Executive Summary

As part of the ongoing effort to estimate the foreseeable impacts of aggressive minimum efficiency performance standards (MEPS) programs in the world's major economies, Lawrence Berkeley National Laboratory (LBNL) has developed a scenario to analyze the technical potential of MEPS in 13 major economies around the world[1]. The "best available technology" (BAT) scenario seeks to determine the maximum potential savings that would result from diffusion of the most efficient available technologies in these major economies.

The analysis of the BAT scenario uses the Bottom-Up Energy Analysis System (BUENAS) to estimate potential impacts and savings for a wide range of residential and industrial end uses. BUENAS has previously been used to estimate potential national energy savings (NES) and carbon dioxide (CO_2) mitigation potential from MEPS around the world, for the Collaborative Labeling and Appliance Standards Program (CLASP) and the Super-efficient Equipment and Appliance Deployment (SEAD) initiative (McNeil et al. 2011).

In this analysis, we bring together engineering knowledge of the technologies evaluated, from studies such as *Max Tech and Beyond* (Desroches and Garbesi 2011), with BUENAS' capability to model the international impact of MEPS. This combination allows us to provide highly accurate estimates of maximum potential savings resulting from implementation of standards requiring BAT in 13 major economies around the world. We assume that the BAT standard would become mandatory worldwide as of 2015. BAT is defined as the most efficient product on the market for each end use, or the most efficient product that could be engineered with currently available components.

We present the impacts of BAT MEPS for each end use in terms of site energy savings and CO_2 emissions savings in 2020 and in 2030. We find that the impacts of adopting BAT MEPS globally are:

- 1,200 terawatt hours (TWh) of electricity savings in 2020 and 2,300 TWh in 2030
- 1,400 petajoules (PJ) of fuel savings in 2020, and 3,500 PJ in 2030
- 27-percent energy reduction among residential end uses and 6-percent among industrial end uses in 2030
- 860 million tons (Mt) reduction in annual CO_2 emissions by 2020 and 1,700 Mt by 2030
- Emissions reductions equal to 11 percent of total reduction needed to reach 450 parts per million (ppm) CO_2 by 2030
- 17 gigatons (Gt) of cumulative emissions savings between 2015 and 2030
- Emissions reductions from electricity generation equal to 60 percent of the total reduction needed to reach 450 ppm CO_2 by 2030

Scenario Description and Rationale

The BAT scenario targets represent the maximum achievable energy-efficient designs, based on emerging technologies that are commercialized (or will be soon) but have a small market share, or designs that combine the most efficient currently available components. In cases where neither of these options is available, the analysis uses an aggressive target from an existing efficiency program. BAT targets exclude promising technologies that are in development but are several years away from commercialization. In

---

[1] The countries modeled in BUENAS are the SEAD participating countries: Australia, Brazil, Canada, the European Union, India, Indonesia, Japan, Mexico, Russia, South Korea, South Africa, and the United States. China, an observer to the SEAD process, is modeled as well. Overall they represent 77% of world energy consumption in 2005 (IEA data).

1

addition, large-scale production of products or technologies that meet the BAT targets must be feasible by 2015.

The BAT scenario is built on the BUENAS business-as-usual (BAU) scenario. BAT targets are determined according to the above criteria using a variety of sources, such as: technical analysis studies performed by LBNL in support of the SEAD initiative, the *Max Tech and Beyond* study, technical support documents (TSDs) developed for United States Department of Energy (U.S. DOE) standards programs, preparatory studies from the European Commission Ecodesign program, and the Japanese Top Runner program's target definitions.

Scope of Scenario Coverage

Because BUENAS has been used to support the activities of SEAD (which is an initiative within the Clean Energy Ministerial process), BUENAS includes all SEAD participating countries as well as China. Table ES-1 shows the appliances and countries covered in the BAT and BAU scenarios in the current study. The end uses and countries covered in the BAU scenario are shaded, and the BAT is marked by an "X." Data on BAT for commercial sector end uses were not sufficient to include in this study. In the residential and industrial sectors, the BAT scenario coverage is broad, including nearly all end uses. Notable exceptions are cooking and space heating, for which coverage is also sparse in the current version of BUENAS.

Table ES-1. Comparison of BAU and BAT Scenario Scope
Shaded cells = countries covered in BAU scenario; X = countries covered in BAT scenario

	Appliance	AUS	BRA	CAN	CHN	EU	IND	IDN	JPN	KOR	MEX	RUS	USA	ZAF
RES	Air Conditioner	X	X	X	X	X	X	X	X	X	X	X	X	X
	Central AC	X		X							X		X	
	Cooking Equip.													
	Fans	X	X	X	X	X	X	X	X	X	X	X	X	X
	Laundry				X	X			X	X				
	Lighting	X	X	X	X	X	X	X	X	X	X	X	X	X
	Freezers					X							X	
	Refrigerators	X	X	X	X	X	X	X	X	X	X	X	X	X
	Boilers				X	X	X						X	
	Furnaces				X								X	
	Space Heating													
	Standby Power	X	X	X	X	X	X	X	X	X	X	X	X	X
	Televisions	X	X	X	X	X	X	X	X	X	X	X	X	X
	Water Heaters	X		X	X	X					X		X	
IND	Distribution Transformers			X	X		X						X	
	Electric Motors	X	X	X	X	X	X	X	X	X	X	X	X	X

AC = air conditioning; AUS = Australia; BRA = Brazil; CAN = Canada; CHIN = China; EU = European Union; IND = India; IDN = Indonesia; JPN = Japan; KOR = South Korea; MEX = Mexico; RUS = Russia; USA = United States of America; ZAF= South Africa

BUENAS Version 04-23-12 Rev 07-27-12

Potential Savings Results and Conclusions

Table ES-2 presents the estimated end-use energy savings and CO_2 emissions reductions in 2020 and 2030 for the BAT scenario.

Table ES-2. Final Energy Savings and Emissions Reductions from BAT Scenario

End Use	Annual Savings in 2020				Annual Savings in 2030				Cumu-lative
	Elec.	Gas	% reduction vs. BAU	CO_2	Elec.	Gas	% reduction vs. BAU	CO_2	CO_2
	TWh	PJ	%	Mt	TWh	PJ	%	Mt	Gt
Air Conditioning	220		20%	150	550		37%	360	3.3
Fans	65		32%	54	130		54%	100	1.1
Lighting	200		42%	120	100		22%	60	1.7
Refrigerators & Freezers	130		21%	88	320		44%	200	1.9
Space Heating	0	690	6%	59	0	1,800	14%	150	1.3
Standby	150		65%	94	270		90%	170	1.8
Television	51		28%	30	100		45%	58	0.6
Laundry	40		15%	24	90		28%	65	0.7
Water Heating	140	740	18%	120	320	1,700	37%	250	2.4
Total Residential	**1,000**	**1,400**	**16%**	**740**	**1,900**	**3,500**	**27%**	**1,400**	**14.8**
Transformers	44		11%	31	130		27%	84	0.7
Motors	130		2%	90	310		5%	210	1.9
Total Industry	**170**		**3%**	**120**	**440**		**6%**	**290**	**2.6**
Total	**1,200**	**1,400**	**10%**	**860**	**2,300**	**3,500**	**19%**	**1,700**	**17.4**

Our study shows that implementation of aggressive policies targeting technically achievable efficiencies can reduce final energy consumption by 19 percent in 2030 in the residential and industrial sectors compared to business as usual. As a result, worldwide annual CO_2 emissions would be reduced by 860 Mt in 2020 and 1.7 Gt in 2030. As a comparison, recently implemented or in-progress standards from SEAD partner countries will save an estimated 220 Mt of CO_2 by 2030 (McNeil et al., 2012). To put our results in context, we compare them to the reductions that the International Energy Agency (IEA) deems necessary to stabilize global CO_2 concentration at 450 ppm (IEA 2010). Emissions mitigation from the BAT scenario would cover about 11 percent of the total emissions gap of 15 Gt[2], which includes energy demand reductions in buildings, industry, and transport as well as increases in the share of renewable energy. The BAT scenario provides 80 percent of required savings target for residential buildings and 25 percent of the savings for industry. Overall, implementation of BAT for electricity end uses in the residential and industrial sectors would provide 60 percent of the total final electricity demand reduction that is needed.

The main message of the BAT scenario is that widespread adoption of technologies that will already be marketable in the buildings and industry sector by 2015 could have a much greater impact on energy use and CO_2 emissions than current policies would have.

---

[2] IEA's *World Energy Outlook 2010*. Comparison of "current policies" and "450 ppm" scenarios in 2030.

BUENAS Version 04-23-12 Rev 07-27-12

4